include some additional species, but the Cyperaceae (19 genera and 97 species, 6 of which are new), Rubiaceae (16 genera and 36 species, 11 of which are new), and Filices (39 genera and 86 species, 18 of which are new) are presented with a measure of completeness. Aside from these families, the largest additions of new species are to Ericaceae (14), Euphorbiaceae (12), and Musci (10).—J. M. C.

Paleobotanical literature.—The third volume of JONGMAN'S *Die palaeobotanische Literatur* has appeared,[6] including the bibliography of 1910 and 1911. The great usefulness of this publication needs no explanation, and now that paleobotany has come to be an essential part of the morphology of vascular plants, it will serve a much larger group of botanists than the title once would have indicated. The list of authors (40 pp.) includes 374 names, representing 762 titles. The list of literature is admirably organized, so that almost any clue can be followed to the literature of a subject.—J. M. C.

NOTES FOR STUDENTS

The mucors.—Prominent among recent publications on the Mucoraceae are two papers by HAGEM[7] which deal with the distribution, taxonomy, and physiology of the soil-inhabiting mucors occurring in the vicinity of Christiania, Norway. A systematic search has revealed the presence in the soil of an unsuspected wealth and variety of these organisms, strangely in contrast with the rarity of their spores in the atmosphere. In the first paper, which deals with taxonomy and distribution, 20 species are described. Of these, 16, including 7 new species, were isolated from cultivated and forest soils. Most of these were isolated many times and some were present in remarkable abundance. Among the most frequently encountered species, *Mucor racemosus*, *M. hiemalis*, and *M. nodosus* are abundant in cultivated lands; *M. Romannianus* is most frequent in coniferous forests (50,000 spores per gram of soil), but *M. strictus*, *M. flavus*, and *M. sylvaticus* are also common. Some forms like *M. racemosus*, *M. hiemalis*, *Absidia Orchidis*, and *Zygorynchus Moelleri* are widely distributed both in cultivation and in forest soils. As showing the rarity of the spores of mucors in the air, only 8 species were isolated by means of Petri dishes containing culture media, and exposed for periods of 1–2 hours both in town and country.

The second paper deals chiefly with problems of nutrition. A large number of compounds were tested with respect to their availability as sources of

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[6] JONGMANS, W. J., Die palaeobotanische Literatur. Bibliographische Übersicht über die Arbeiten aus dem Gebiete der Palaeobotanik. Dritter Band. Die Erscheinungen der Jahre 1910 und 1911 und Nachträge für 1909. pp. 569. Jena: Gustav Fischer. 1913. *M* 26.

[7] HAGEM, O., Untersuchungen über norwegische Mucorineen. I. Videnskab. Selsk. Skrift. no. 7. pp. 50. *figs. 22.* 1907; *ibid.* II. no. 4. pp. 152. 1910.

nitrogen and of carbon for the mucors. The mass of detail is too great and too diverse to permit of recapitulation; the main features of the results, however, may be briefly summarized. The 23 mucors studied fall into two clearly separated groups with respect to their ability to assimilate nitrogen from nitrates and nitrites. In relation to these compounds it is interesting to note that all forms which were capable of assimilating nitrates were also capable of assimilating nitrites. As with other plants, the nitrates are reduced to nitrites and these to ammonia in the process of assimilation. All forms grew well when nitrogen was supplied in the form of ammonium salts. On urea, 18 species thrived, but *Mucor Romannianus* failed. In cultures with urea, ammonium carbonate is formed. Acetamide is not utilized. Uric acid is only slightly soluble, but gives good growth. The amino-acids have little nutrient value when they are the sole source of both carbon and nitrogen. When carbon is supplied in the form of glucose, the amino-acids, especially leucine and tyrosine, are utilized as a source of nitrogen by many of the soil mucors. In all cases ammonia accumulates in the culture medium. Of the non-nitrogenous carbon compounds, mannite and glycerin are not used when ammonium sulphate is the only source of nitrogen; with potassium nitrate, however, these polyatomic alcohols are assimilated by 3 or 4 species. With the exception of maltose, the disaccharides are not used except in a few cases. Six species grew well on saccharose, but of these only two showed the accumulation of reducing sugar in the culture fluid. The species which thrive on saccharose are unable to utilize that sugar when amino-acids serve as the only source of nitrogen. In explanation the author suggests that the action of the invertase of the fungi is inhibited by the presence of ammonia split off from the amino-acids. Starch in general seems not to be utilized, a fact which is all the more interesting since the conversion of starch into glucose by some species of *Rhizopus* is the basis of a commercial process. Few species grow on inulin and pectin, but some on xylan and cellulose. Of the glucosides, helicin and salicin were tried. Helicin proved valueless, while a number of mucors were capable of utilizing salicin, but only to a limited extent because of the toxic properties of the decomposition products formed.

These results on the whole seem to indicate that most of the common substances which reach the soil from the plant are only poorly suited for the nutrition of a group constituting, according to these investigations with the exception of the bacteria, one of the most abundantly represented classes of soil-organisms. It would be an interesting problem to determine to what extent the nutrition of soil mucors is dependent upon decomposition of plant products brought about by bacteria and other soil organisms.

In a third paper,[8] which forms the conclusion of HAGEM'S investigations of Norwegian mucors, the author gives critical notes on their nutrition. *Mucor*

[8] HAGEM, O., Neue Untersuchungen über norwegische Mucorineen. Ann. Myc. 8:265–286. *figs.* 11. 1910.

saturninus, *M. christianiensis*, *M. dispersus*, and *M. corticolus* are described as new in this paper. *M. norwegicus* Hagem, which was described as new in the first paper, is here regarded as a synonym of *M.* (*Rhizopus*) *nodosus* (Namyslowski) Hagem.

NAMYSLOWSKI[9] describes a new species of *Zygorynchus* isolated from the soil. This species, like the other species of the genus (*Z. Moellerii* and *Z. heterogamus*), is monoecious.

In another paper,[10] NAMYSLOWSKI has reported a long series of experiments in which, after the fashion of KLEBS, he attempts to determine the influence of various food substances in different concentration on the production of zygospores and sporangia by the mucors. The data do not allow of either general or precise conclusions, but show that the kind and concentration of nutrients have a not very well defined influence in determining the relative abundance of zygospores and sporangia. The work further brings out the fact that the distinction between monoecious and dioecious species is not always sharp, for some of the monoecious forms, like *Zygorynchus*, produce zygospores along the line of contact between two adjoining colonies, and some dioecious species show a tendency to form zygospores on mycelia derived from single spores. In one case, *Absidia glauca*, the author even succeeded in isolating a monoecious race from a species which is usually considered to be dioecious.

A number of short papers by different authors treat of the formation of zygospores and of nuclear phenomena in the mucors. LENDNER[11] has examined the method of origin of the zygospore in a number of mucors representing both monoecious and dioecious species. His observations go to show that the gametangia originate at points where two branches of the mycelium accidentally come into contact, and not, as is usually stated, on branches which grow toward each other as the result of some sort of a stimulus. MOREAU,[12] who has studied nuclear phenomena in the hyphae and zygospores of several mucors, reports that the divisions in the hyphae and gametangia are normally mitotic and simultaneous. In the columella of *Rhizopus* amitotic divisions, which

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[9] NAMYSLOWSKI, B., *Zygorynchus Vuilleminii*, une nouvelle mucorinée isolée du sol et cultivée. Ann. Myc. **8**:153–155. *figs. 9.* 1910.

[10] NAMYSLOWSKI, B., Studien über Mucorineen. Bull. Intern. Acad. Sci. Cracovie. Ser. B. 1910:577–519. *figs. 2.*

[11] LENDNER, A., Observationes sur les zygospores des Mucorinées. Bull. Soc. Bot. Genève. II. **2**:56–59. *figs. 4.* 1910.

[12] MOREAU, F., Première note sur les Mucorinées, le noyau au repos.—Le noyau en division: mitose et amitose. Bull. Soc. Mycol. France **27**:204–210. *figs. 12.* 1911.

———, Deuxième note sur les Mucorinées.—Fusions de noyaux et dégénérescence nucléaire dans la zygospore.—Fusions de noyaux sans signification sexuelle. *Ibid.* 334–341. *figs. 4.*

———, Les phénomènes internes de la reproduction sexuelle chez quelques Mucorinées hétérogames. Bull. Soc. Bot. France **58**:618–623. *figs. 4.* 1911.

apparently indicated degeneration, were observed. In the zygospores he finds that multiple fusion with degeneration of the supernumerary nuclei takes place. The fusion is preceded by a division. *Zygorynchus* offers a variation from other forms in the fewness of the nuclei which fuse (4 in one species) and in the tardiness of the fusion.

The process of zygospore formation in *Zygorynchus*, according to GRUBER,[13] shows some peculiarities which have not been observed in mucors heretofore. The zygospore arises at the point of contact between the terminal portion of an erect hypha and a lateral branch arising from the same hypha or rarely from a different hypha. At the point of contact the gametangia grow out from each hypha. Only the female gametangium is cut off by a wall at its base from the parent cell. Later a partly formed wall arises midway between the base and apex in the female gametangium, but this wall is rarely completed and soon disappears. The male gametangium remains in connection with the parent hypha. After the fusion of the gametangium a differentiated portion of the protoplasm of the male gametangium passes into the female gametangium, carrying with it 20–30 nuclei. The fusion of nuclei was not observed on account of their minuteness. The author believes that a multiple fusion takes place and that subsequently the fused nuclei divide to give the large number subsequently found in the zygote. He does not note the reduction in number observed by MOREAU. The resemblance of the manner of formation of the zygospore in this form to that of oospores suggests that *Zygorynchus*, which in other characteristics corresponds with the mucors, is akin to the oomycetes.—H. HASSELBRING.

Cecidology.—A very interesting and valuable contribution is a study of a citrus tree cecidium caused by *Sphaeropsis tumefaciens* Hedges by HEDGES and TENNY.[14] The organism was first isolated from lime tree knots from Jamaica in 1904. The knots vary in size from $\frac{3}{8}$ to 3 inches, and are usually more or less spherical; they are light in color and smooth when young but become black and furrowed with age. The interior of the knot is hard and compact, while the outer part is soft and crumbling in character. They are frequently more or less covered with typical witches-broom growths. They occur on both old and young growths and at any season of the year, and eventually cause the death of the plant. The mycelium may grow in any tissue, but is confined to the intercellular spaces, but unfortunately the authors have not given a discussion of the structural characters of the malformations. The fungus penetrates the wood for considerable distances beyond the point of inoculation, thus making pruning an unsatisfactory treatment. Pycnidia

[13] GRUBER, E., Einige Beobachtungen über den Befruchtungsvergang bei *Zygorynchus Moelleri* Vuill. Ber. Deutsch. Bot. Gesells. **30**:126–133. *pl. 1.* 1912.

[14] HEDGES, FLORENCE, and TENNY, L. S., A knot of citrus trees caused by *Sphaeropsis tumefaciens*. Bull. no. 247. U.S. Dept. Agric. Bur. Pl. Industry. 1912.